mental life of a great university is measured by the number and activities of its teachers and students who are actually engaged in productive scholarship.

During the period when trustees and regents have been more keenly interested than ever before in discussing the question as to whether the ideals of the high school and college should or should not dominate the policy of the university, two great foundations, the Carnegie and Rockefeller Institutions, have been dedicated to the advancement of learning. Gradually the real significance of their independent existences is becoming more and more apparent to those persons who are competent to form an opinion upon the nature and scope of university problems. The American university to-day is an institution devoted primarily to teaching, while its assumed right to the title of a seat of learning is still open to question. Will the old bottles hold the new wine? If they do not then the intelligent interest of a rapidly increasing number of American citizens, competent to distinguish the essential differences between collegiate and university ideals, will within a few years provide the means for the establishment of "higher institutions of learning."

Stewart Paton

Princeton, N. J.

PHYSIOLOGY AS A FUNDAMENTAL IN VETERINARY EDUCATION[1]

Education, like nature, should be orderly—a development from the simple to the complex. The development of the morphologically simple cell into the complex adult animal organism proceeds in an orderly way. The cell is the morphological unit and the mature animal consists of innumerable units, some of which have undergone a very great modification as to form. The cell can not be accepted as the physiological unit. What is apparently simple as to form is not necessarily simple as to function. The activities of the cell are but partially understood. The physiological unit, around which center these activities, is, like the atom of chemistry, invisible, but its power is unquestioned. Function is concealed in structure. Function is not often revealed without search and, indeed, research. In some instances it may be so superficial as to be easily recognized; in others it may lie so deeply that the keenest intellect is baffled in demonstrating its presence in a satisfactory manner.

The relation of physiology to the biological sciences is most intimate. It is not a question of independence but of interdependence. Many more or less plausible arguments may be advanced that one particular science may have a greater relative value than others. Chemistry and physics are concerned with matter and we ordinarily associate them with unorganized bodies. Physiology is restricted to *living* matter, or organized bodies. We can not consider inorganic material in physiological terms. Yet chemistry and physics are intricately involved in physiological processes and the question arises, perhaps, in the minds of some if, under the proper combination of conditions and of environment, life is not evolved from chemical reactions. Chemical action is constantly occurring in living tissue. Does it control the living tissue or does the living tissue control it? In the processes of filtration, diffusion and osmosis, physics occupies a relationship scarcely less intimate than chemistry. Solutions of crystallizable substances of unequal concentration separated by an animal mem-

[1] Presented at the meeting of the Association of Veterinary Faculties and Examining Boards of North America at Toronto, Canada, August, 1911.

brane will ultimately become uniform. Physics has demonstrated this. Is there any difference in the results if the animal membrane be living or dead? In some instances it has been shown that it does. Waymouth Reid introduced into the intestine of a living animal a certain amount of its own blood serum. The epithelial cells of the alimentary tract were therefore in contact on the one side with this blood serum and on the other with capillary vessels containing blood, the fluid of which had the same composition as the serum in the intestine. If the intestinal wall acted like an ordinary dead membrane there could be no passage of the serum from the intestine to the blood by diffusion or osmosis. It was found that the serum was rapidly absorbed. This could not be due to ordinary filtration because the pressure in the intestine was less than in the capillaries. The conclusion was reached that while known physical forces play a certain part in absorption, there remains an unexplained factor. Some, however, regard this unexplained factor as the living cell and that because of its living condition two separated fluids of uniform composition were made to unite against pressure.

A somewhat similar example occurring in the kidney may be referred to. Urine contains a much higher percentage of urea than does the blood, but in spite of that the extremely weak solution of the urea in the blood gives up its urea to the more concentrated solution in the urine. Physical law will permit the passage of a substance from the stronger to the weaker solution, but not the reverse.

Cooperation is the key-note of physiology. In no other science, perhaps, do we have such striking examples. Since the time of Sir Charles Bell, physiologists have recognized the importance of the nervous system in coordinating and regulating the various bodily functions. In comparatively recent years the realization has grown that the harmonious adjustment of the various tissues is not confined entirely to the numerous reflexes through the nervous system, but that there is in addition a regulation by chemical means through the blood and other fluids of the body. The development of our knowledge of the internal secretions led Brown-Sequard to the generalization that every tissue in the body in the course of its normal function gave material to the blood which was of use in regulating the activity of other tissues. This idea has been supported by facts brought out in connection with the study of the ductless glands of the body. The generalization of Brown-Sequard has been confirmed in a definite way by the investigations of Bayliss and Starling upon secretin. They have demonstrated that when hydrochloric acid is brought in contact with the epithelial cells of the duodenum a substance (secretin) is produced which passes into the blood and is carried to the pancreas and stimulates it to secrete the pancreatic juice. This is a definite example of a substance which, originating in one tissue, is of direct aid in the function of another tissue in a chemical way. Such a substance has been designated by Starling as a "hormone."

The epithelial cells of the duodenum cooperate in still another very striking manner. When the pancreatic juice is secreted its proteolytic enzyme is in the form of trypsinogen—an inert substance. As soon as it comes in contact with the duodenum, the trypsinogen is activated or converted into trypsin, which has the power of acting vigorously upon proteid material. The substance which causes this activation is known as enterokinase. It would thus appear that the duodenal cells are doubly cooperative in assisting other tissues in a

chemical way. The secretin which they produce is comparable to an internal secretion, since it is turned into the blood and stimulates the pancreas to perform its function; the enterokinase, on the other hand, is comparable to an external secretion since it is turned into the intestinal cavity and thereby activates one of the important constituents of the pancreatic secretion.

An interesting cooperative cycle is apparently established around the duodenum. In the stomach, pepsinogen is secreted by certain cells in the gastric glands; this presumably is activated to pepsin by the hydrochloric acid formed by another type of cell in the gastric glands. The gastric chyme with its hydrochloric acid, on reaching the duodenum, stimulates the production of secretin, which in turn stimulates the flow of the pancreatic juice. The pancreatic secretion on reaching the duodenum induces the production of enterokinase by which its trypsinogen is activated to trypsin.

Because of the considerable amount of carbohydrate in the diet, it might naturally be expected to find a vigorous diastatic enzyme in the saliva of the horse, if in any animal. Yet the saliva taken from the duct of the parotid gland is unable to convert a starch mixture into a reducing sugar except to a very limited extent and after a considerable period of time. Is there an absence of the diastatic enzyme, except such as may filter through to the secretion from the blood, or is there an inert ptyalinogen which meets its activator further down the tract and is there converted into the active ptyalin?

Other examples of cooperation may be mentioned in connection with the pituitary body of the brain, and the thyroid and suprarenal glands. Although not provided with ducts, an internal secretion is nevertheless formed which is turned into the blood and lymph and exerts an influence upon the other tissues of the body so important that if the glands become diseased or removed, serious or fatal consequences result.

One of the most interesting examples of an internal secretion which is not necessary to life but which yet profoundly affects the chemical changes occurring in the body is that of the ovaries. It has long been familiar to stockmen and others that the removal of the ovaries increases considerably the rapidity with which fat is laid on. According to the researches of Loewy and Richter of Berlin the explanation is that the ovaries produce a substance which hastens the oxidation of the tissues and the food. When this substance is injected under the skin of animals in which the ovaries have been removed, the tissue waste is markedly increased.

Since physiology is concerned with living matter and that alone, the border lines between it and other biological sciences must of necessity be indefinite and more or less overlapping. This is peculiarly true as to its relation with pathology, medicine and therapeutics. The chief function of the living tissues is change—metabolism. Changes of composition, form or even structure are pertinent to physiology if they occur in the living tissue. The activity of the tissues may be increased or decreased for a greater or less time and the conditions still remain within normal limits. There may be a lack of cooperation for a time without abnormal results. The dividing line between the normal and the abnormal is at the outset imperceptible. Bacteria are present in the normal body and are more or less concerned with the normal functions of the alimentary tract.

Physiology stands for cooperation, pathology deals with a disturbed coopera-

tion. A tissue unduly excited will, in time, disturb the harmonious adjustment of certain other tissues producing a chain of results which induces an abnormal or pathological effect upon the organism, as a whole, and medical science is invoked to alleviate the disturbed condition and to restore the normal adjustment. In other instances the hyperexcitability may be localized in a given tissue, as with a benignant tumor without apparent interference with the normal functions of the other parts. Pathology is physiology gone wrong and, although it has been emphasized before, it is well to emphasize it again: that to understand the abnormal, it is necessary to have as complete a knowledge as possible of the normal organism.

If it is the province of pathology to point out the differences between the normal and abnormal, it is the very important duty of medical science to attempt the restoration of the abnormal to the normal. If it is important for the surgeon to know thoroughly the form and structure of the tissues in order that abnormal or diseased parts may be removed with the hope of bringing about a normal condition again; then is it equally important for the medical practitioner to know thoroughly the functions of the tissues and their system of cooperation, if he is to restore the diseased organism to its normal physiological standard. Therapeutics must be invoked with a knowledge of those agents which will stimulate the weakened parts to their normal tone, or which will soothe the overirritable or overexcited tissues to their natural calm. Without anatomy we may assume there could not be proper surgical procedure; we may equally assume that without physiology there could not be satisfactory medical practise. Indeed, the practitioner's service is but an extended laboratory course in physiology.

Diseases are due to a disturbance of physiological cooperation either internally through the interrelationship of the different tissues or externally from the introduction of material foreign to the organism. In veterinary practise there is perhaps no more striking example of disturbed cooperation than in azoturia. Why should renewed work after a day or two of idleness cause such a physiological upheaval in the horse as to make it necessary to record so large a percentage of fatalities? The answer will probably be found in the disturbed adjustment of the circulation, muscular and renal tissues, caused, perhaps, through chemical substances introduced through the digestive system and influenced more or less by external conditions. Why are other domesticated animals exempt from this affection? The hydrocephalic dummy, parturient paresis in cattle, and many other diseases when finally worked out may be found to be due to the production of some chemical substance developed in one tissue, which, circulating to other tissues, excites them directly or reflexly to such an extent that the whole adjustment is thrown into more or less disorder.

In the urine of man, more than a trace of indican is pathological. Why should the relatively large amount of this substance usually found in the urine of the horse be regarded as a normal condition?

In order to solve the problems of the normal as well as the abnormal, it would appear essential to work out the physiology of each species of the domesticated animal distinctly. While many of the conditions may be fundamental to all, there are some characters which are peculiar to each type. Physiology is not all internal; external conditions must be reckoned with. Diet, habit and environment all contribute to

the harmonious adjustment of the internal mechanism.

The practitioner should not be blamed too severely for a certain amount of empiricism. Physiology has not yet solved all of its problems and until the solution is forthcoming a strictly rational treatment of all diseases is impossible.

If my meaning has been clearly expressed, it should be apparent that physiology is a *living* science and is concerned with the manifestations of life; its action is cooperative, not only to the tissues in an individual organism, but in a broader sense to the other biological sciences; it is fundamental especially to pathology and medicine, and, cooperating with them, seeks to conserve the general health of animals and man.

Pierre A. Fish

Cornell University

ADDITIONAL FACTS ABOUT THE CHESTNUT BLIGHT

Through a desire to be as concise as possible, the early history of the chestnut blight investigation in Pennsylvania was not given in my recent account in Science. As there seems to be a demand for the facts, the following is submitted:

On June 13, 1908, Professor John W. Harshberger received a letter from Mr. Harold Peirce, of Haverford, asking if the University of Pennsylvania could detail a man to investigate the work of a borer, or of a fungus, on the chestnut trees in his woodland at Haverford. Under date of June 18, 1908, Mr. Peirce arranged for Professor Harshberger to inspect his trees with a view to discovering the cause of their disease. As a result of the microscopic study, it was found that the trees were attacked by the chestnut blight fungus recently described by Dr. Murrill, of New York. Thus Mr. Peirce became deeply interested and called together a number of public-spirited citizens. Several public meetings were held at which Professor John Mickleborough and Professor Harshberger gave an account of the life history of the fungus and what might be done to stay the advance of the blight. Subsequently, at the suggestion of Professor Harshberger, a committee of the Main Line Citizens' Association requested the Pennsylvania Department of Forestry to assist in inspecting the chestnut trees in the neighborhood of Bryn Mawr and Haverford. On May 3, 1910, a meeting was held at the house of Mr. Robert W. Lesley, at which meeting, in response to their request, the Deputy Commissioner of Forestry (the undersigned) met with the committee and formulated the chestnut blight campaign. As a result of the agitation, the committee of the Main Line Citizens' Association, consisting of Messrs. Harold Peirce (Chairman), Theodore N. Ely, Allan Evans, Edgar C. Felton, William Righter Fisher, Alba B. Johnson and Robert W. Lesley, under date of August 1, 1910, issued an appeal to the property holders of their neighborhood for money to make a preliminary inspection.

The response was a generous one, so that the committee secured the assistance of Mr. George H. Wirt, state forest inspector, and a force of student foresters from the State Forest Academy at Mont Alto, under the direction of the writer, while Professor John W. Harshberger, of the Botanical Department of the University, agreed to assist as fungolist and botanist. Mr. Clarence R. Cornman, of Gladwyne, represented the committee in the active field work, while Mr. Oglesby Paul also aided the committee with counsel and advice.

On September 1, 1910, the inspectors from Mont Alto arrived and headquarters were opened in the Merion Title & Trust Company Building in Ardmore. As the work of inspection proceeded the Main Line Citizens' Committee realized that the work had assumed a national scope. At the suggestion of Professor Harshberger, the United States Department of Agriculture was requested to cooperate and a favorable reply to that request was received on November 1, 1910, from Dr. Haven Metcalf, in charge of the office of forest pathology, Bureau of Plant Industry.